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GB 2148874 A GB 2148273 A GB 2016445 A
GB 1427826 A US 4820322 A

(58) Field of Search
UK CL (Edition O) C1M MBA MBB MBL
INT CL^6 C03B 37/012

(54) Making optical fibres by drawing rod-in-tube preforms

(57) A method and apparatus are described for fabricating an optical fibre from a primary optical fibre preform 46 and an overcladding quartz tube 44. A single furnace 28 is used and the primary optical fibre preform 46 and the overcladding quartz tube 44 are mounted on an adjoiner 47 and passed substantially concentrically into the furnace 28, to fuse the primary optical fibre preform 46 and the overcladding tube 44 into a secondary optical fibre preform. Then a capstan 34 draws an optical fibre from the secondary optical fibre preform within the furnace 28.

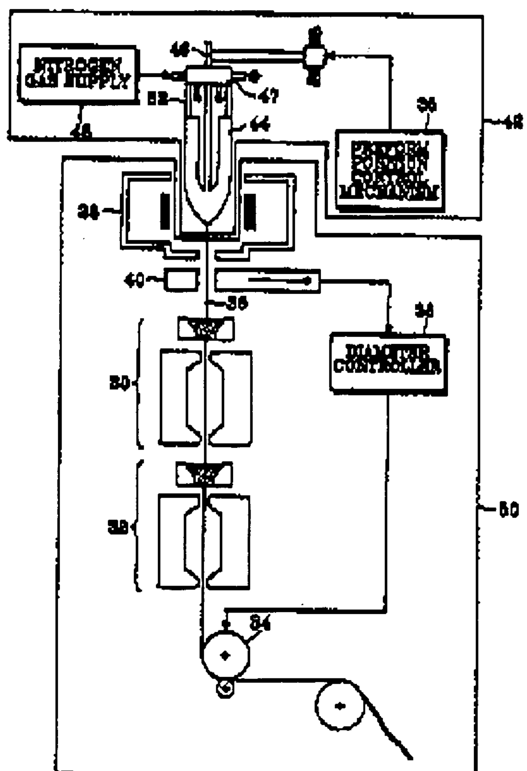

Fig. 5

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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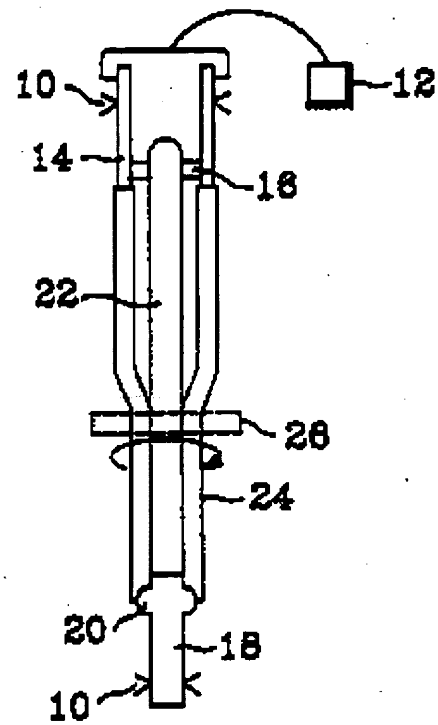

Fig. 1

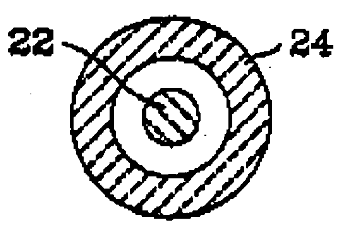

Fig. 2

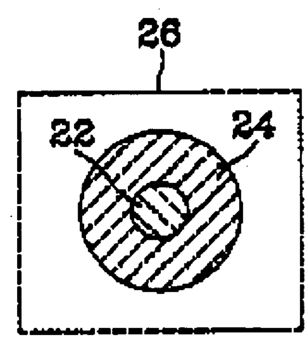

Fig. 3

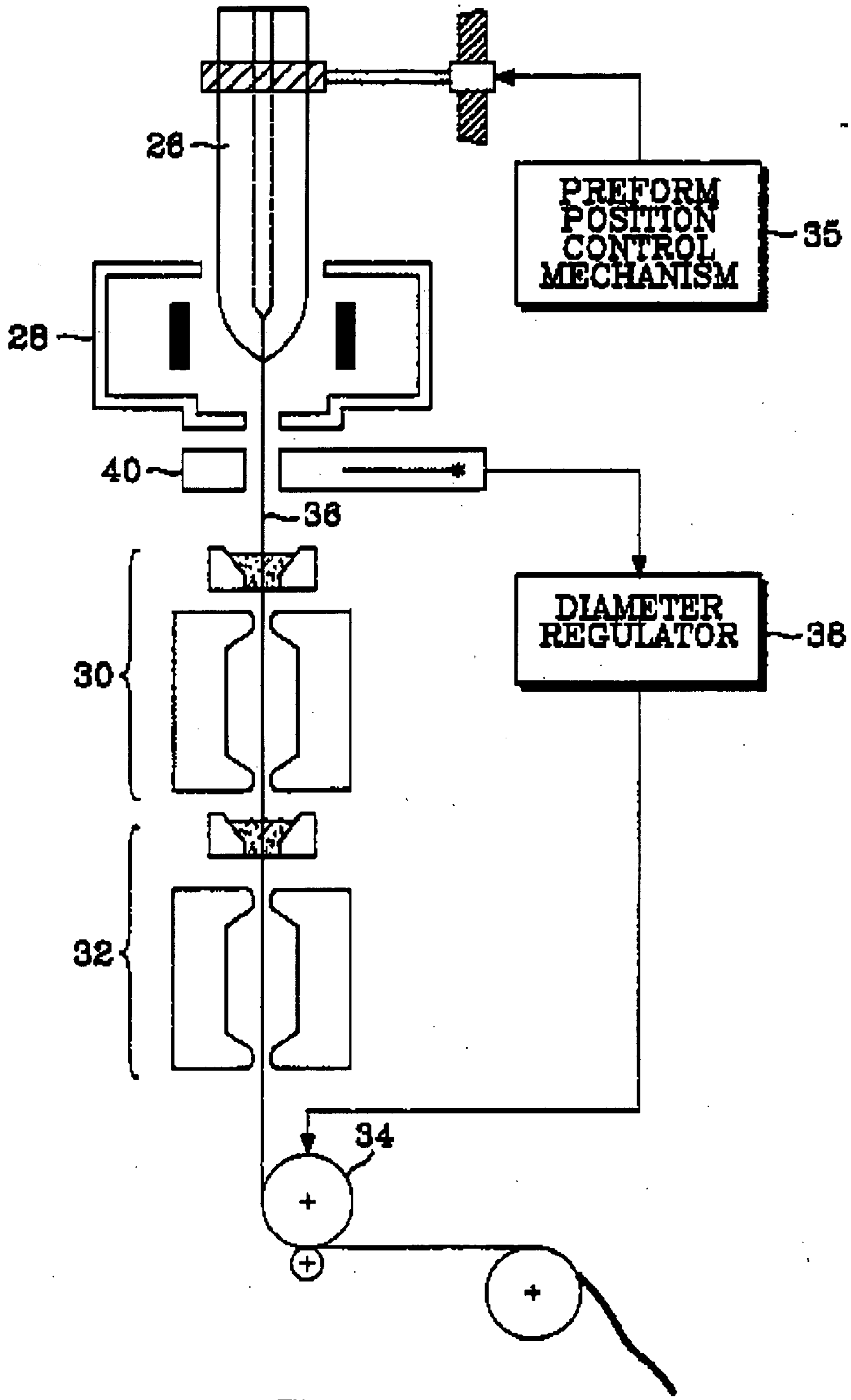
26
28
PREFORM POSITION CONTROL MECHANISM
35
40
36
DIAMETER REGULATOR
38
30
32
34

Fig. 4

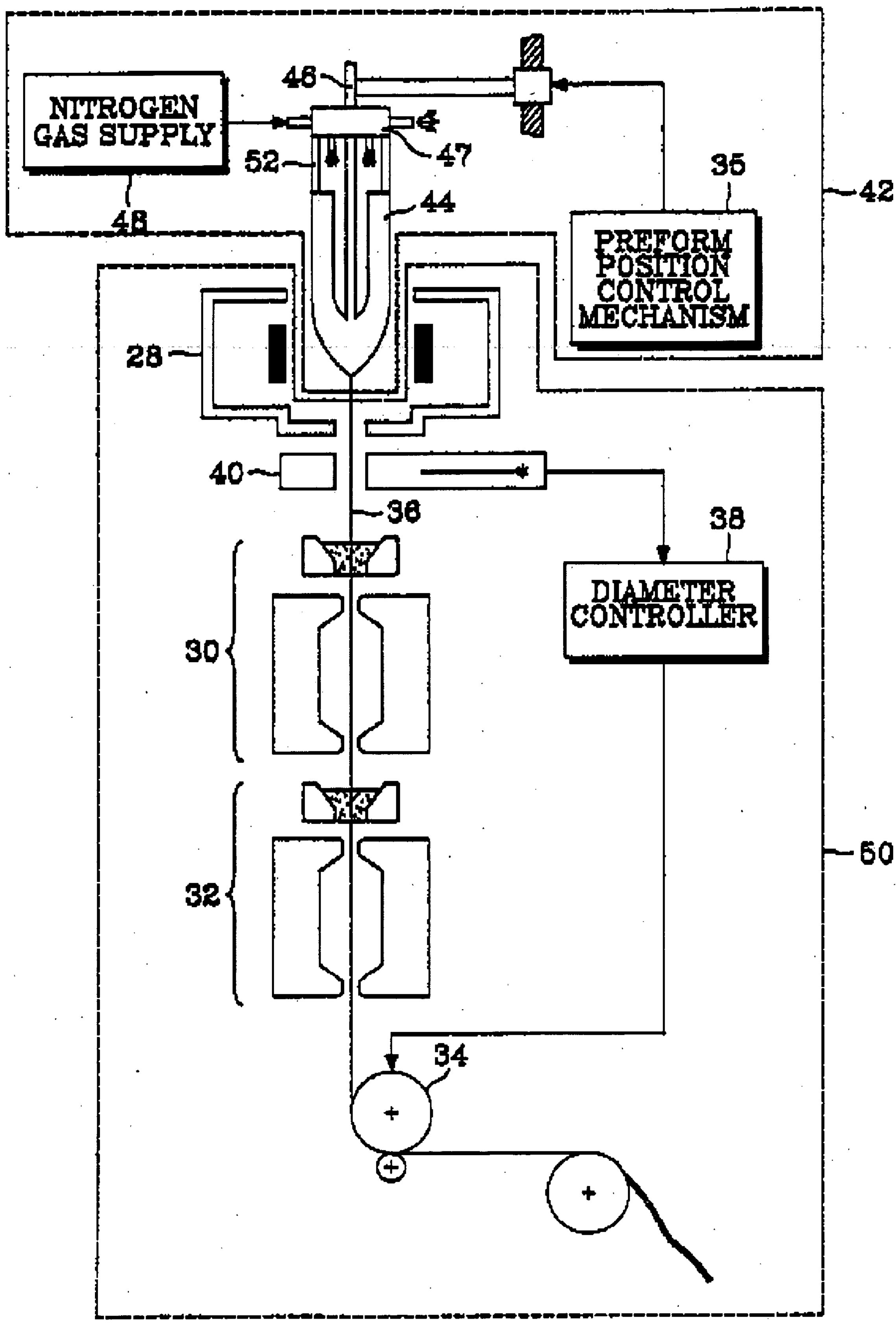
NITROGEN GAS SUPPLY
48
46
47
52
44
35
42
PREFORM POSITION CONTROL MECHANISM
28
40
36
38
DIAMETER CONTROLLER
30
32
50
34

Fig. 5

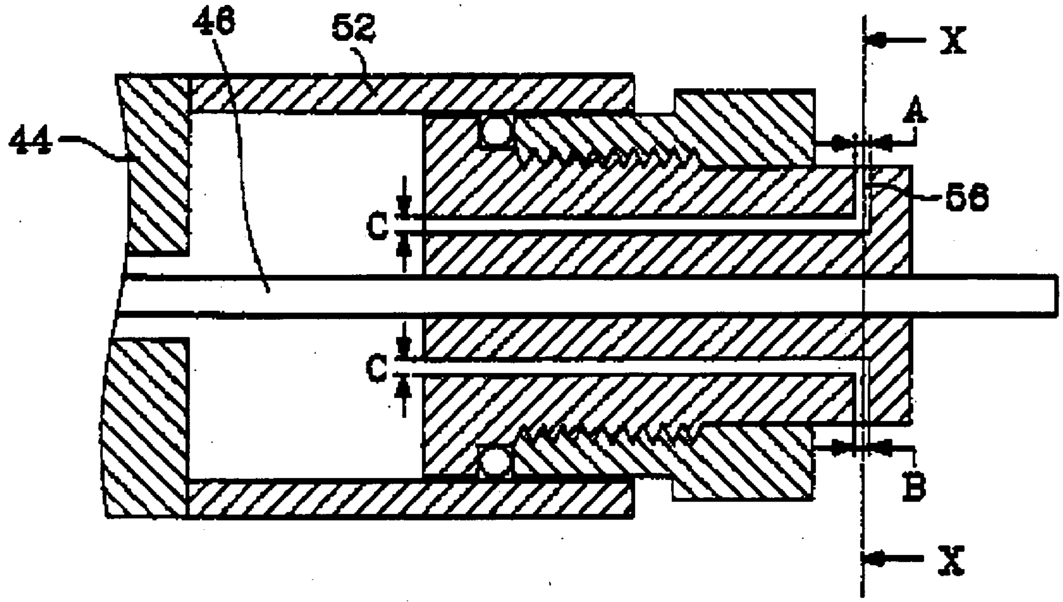

Fig. 6A

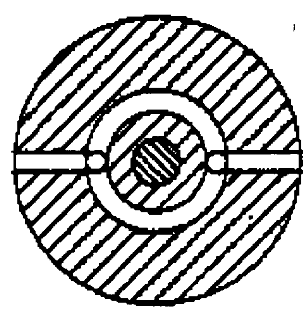

Fig. 6B

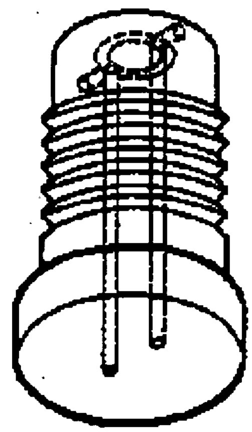

Fig. 6C

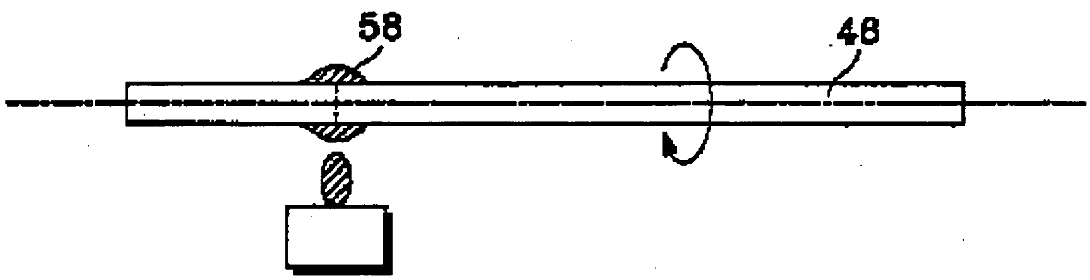

Fig. 7

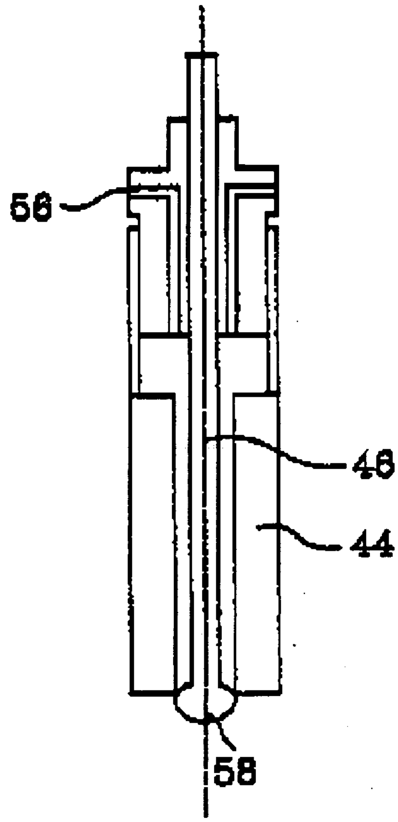

Fig. 8

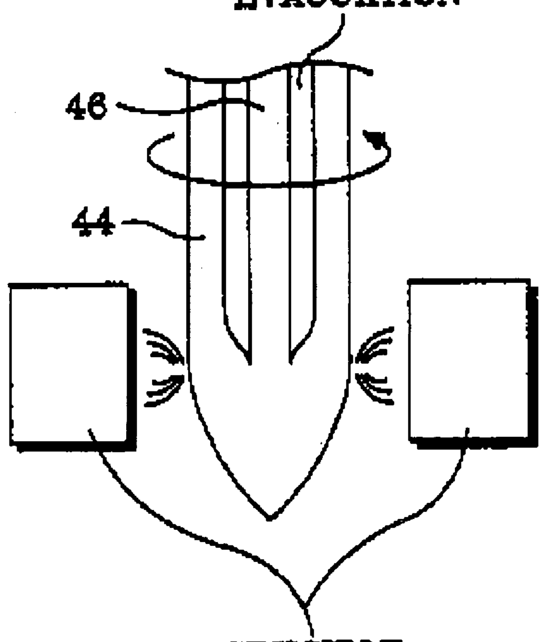

Fig. 9

FABRICATION OF OPTICAL FIBRES

Background of the Invention

The present invention concerns an apparatus for drawing an optical fibre from an optical fibre preform.

Quartz optical fibres currently used for ultra high speed data communication networks are manufactured using outside vapour deposition (OVD) methods or modified chemical vapour deposition (MCVD) methods. OVD methods involve hydrolysing a chemical gas consisting of gaseous $SiCl_4$ and a dopant with concurrently supplied oxygen to deposit SiO_2 soot and dehydrating the deposited soot in a high temperature furnace using Cl_2 and He to sinter it and form an optical fibre preform. MCVD methods deposit several layers inside a quartz tube by supplying a chemical gas consisting of $SiCl_4$ and a dopant concurrently with oxygen. When the several layers are deposited, the cladding part is formed first and the core second. Thereafter, the quartz tube with the deposition is heated and Cl_2 and He supplied to form a compact quartz rod.

However, MVCD methods inherently suffer from the drawback that they are unable to provide a preform with a diameter over 25mm. Hence, to overcome this drawback, a so-called overcladding method is employed to provide a larger preform, thus improving productivity.

The overcladding method will now be described with reference to Figs. 1, 2 and 3. An overcladding tube 24 is provided with a supporting tube 14 of low purity concentrically mounted on one end. The tube 14 has a lower purity than the overcladding tube 24. A support ring 16 is inserted into the supporting tube 14 to centre the primary optical fibre preform and the overcladding tube 24. To this end, it is desirable to make the support ring 16 with a thickness of at least 10mm. Fig. 2 shows the primary optical fibre preform 22 mounted in the overcladding tube

24.

Attached to the lower end of the primary optical fibre preform 22 is a support rod 18, the upper end of which is positioned at the lower end of the overcladding tube 24 and heated to form a swollen globe or bulbous part 20 which seals the lower end of overcladding tube 24 as shown in Fig. 1. The assembled structure is heated longitudinally and rotated to fuse the overcladding tube 24 and the primary optical fibre preform 22 into a secondary optical fibre preform, as shown in Fig. 3.

The process of drawing the optical fibre from the secondary optical fibre preform will now be described with reference to Fig. 4. The optical fibre preform 26 is slowly supplied to a furnace 28 under the control of a preform position control mechanism 35. The furnace 28 is operated at several thousand°C, typically 2100 to 2200°C. The un-coated optical fibre 36 is drawn from the cross-sectionally reduced part of the secondary optical fibre preform 26. The drawing force is generated by the capstan 34.

A diameter measuring device 40 measures the diameter of the un-coated optical fibre 36 and generates a measuring signal which is transferred to a diameter regulator 38 to regulate the diameter at a specified dimension, e.g., 125μm. The diameter regulator controls the drawing force of the capstan 34 in response to the measuring signal so as to maintain the diameter of the un-coated optical fibre 36 at 125μm. The cooled un-coated optical fibre 36 is coated with an acrylic or silicon resin as a protective coating by first and second coaters 30 and 32. Finally the coated optical fibre is wound around the spool 68.

Thus, the MVCD method requires three essential steps: preparing a primary optical fibre preform by internal deposition; overcladding the primary optical fibre preform to obtain a secondary optical fibre preform; and finally drawing an optical fibre from the secondary optical fibre

preform. These three conventional steps are very time-consuming, thus lowering productivity. In addition, overcladding the primary optical fibre preform requires a large amount of oxygen or hydrogen. Furthermore, as the size of the primary optical fibre preform is increased, the amount of heat applied to the preform must be increased, thus degrading the transmission characteristics of the finally obtained optical fibre, such as light loss characteristics.

It is an object of the present invention to provide an improved method and apparatus for overcladding a primary optical fibre preform and drawing an optical fibre.

Summary of the Invention

According to the present invention, there is provided a method of fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube comprising passing the primary optical fibre preform and the overcladding quartz tube substantially concentrically into a furnace to fuse the primary optical fibre preform and the overcladding tube into a secondary optical fibre preform and drawing an optical fibre from the secondary optical fibre preform within the furnace.

Preferably, the primary optical fibre preform is held substantially centrally in the overcladding quartz tube in an adjoiner. The adjoiner may include means for evacuating the annular space between the primary optical fibre preform and the overcladding quartz tube. The means for evacuating the annular space comprises a suction tube and means for passing a flow of gas across the free end of the suction tube.

The method may comprise inserting one end of the primary optical fibre preform to a quartz tube of comparatively low purity, heating that end of the primary optical fibre preform to form a bulbous end, removing the primary optical fibre preform and its bulbous end from the quartz tube of

comparatively low purity, locating one end of the overcladding quartz tube in the adjoiner and locating the primary optical fibre preform in the adjoiner such that its bulbous and is located at the other end of the overcladding quartz tube.

the present invention also provides apparatus for fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube comprising a furnace, means for passing the primary optical fibre preform and the overcladding quartz tube substantially concentrically into the furnace to fuse the primary optical fibre preform and the overcladding tube into a secondary optical fibre preform and means for drawing an optical fibre from the secondary optical fibre preform within the furnace.

<u>Brief Description of the Drawings</u>

The present invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 is a cross-sectional view of a primary optical fibre preform concentrically arranged in a conventional overcladding tube;

Fig. 2 is a transverse cross-sectioned view of the preform and tube of Fig. 1;

Fig. 3 is a view similar to Fig. 2, but with the conventional overcladding tube fused with the primary optical fibre preform;

Fig. 4 is a block diagram illustrating a conventional apparatus for fabricating the optical fibre;

Fig. 5 is a block diagram illustrating an apparatus according the present invention;

Figs. 6A, 6B and 6C illustrate the structure of the adjoiner;

Fig. 7 illustrates the formation of a bulbous end on the primary optical fibre preform;

Fig. 8 illustrates the primary optical fibre preform arranged in the overcladding tube; and

Fig. 9 illustrates the rounding of the lower end of the secondary optical fibre preform round by melting.

Detailed Description of the Preferred Embodiment

In Fig. 5, a preform supply equipment 42 includes an overcladding tube 44, a primary optical fibre preform 46, an adjoiner 47, a preform position control mechanism 35, and a nitrogen gas supply 48. The overcladding tube 44 has the same refractive index as that desired of the final cladding. When the primary optical fibre preform 46 is closely combined with the overcladding tube in a sealed manner, the cross sectional ratio of the core to the cladding is 45:125.

The adjoiner 47 holds the optical fibre preform 46 in the overcladding tube 44 with a regular annular space formed between the sides of the preform 46 and the inside surface of the overcladding tube 40. The preform position control mechanism 35 controls the position of the primary optical fibre preform 46 associated with the overcladding tube 44. The nitrogen gas supply 48 forces nitrogen gas through a pipe-like channel in the adjoiner 47, to evacuate the space between the primary preform 46 and the overcladding tube 44.

The equipment 50 for drawing the optical fibre includes a furnace 28, a diameter regulator 38, first and second coaters 30 and 32 and a capstan 34, which are similar to those described with reference to Fig. 1.

Fig. 6A is a cross-sectional view of the adjoiner, Fig. 6B a transverse cross-sectional view taken along line X-X and Fig. 6C a perspective view. A quartz tube of low purity is provided to connect the overcladding tube 44 with the adjoiner 47 lengthwise. The primary optical fibre preform 46 is fixed and arranged along the centre line of the adjoiner. The adjoiner 47 is provided with an annular groove 56 connected to a nitrogen gas inlet and outlet tube "A" and "B" formed perpendicular to the length of the

adjoiner and with a suction tube "C" extended to the space between the overcladding tube 44 and primary optical fibre preform 46 in parallel with the length. The nitrogen gas is forced to flow into the inlet tube "A" and out of the outlet tube "B" so that the space between the overcladding tube 44 and the primary optical fibre preform 46 is evacuated through the suction tube "C" according to Bernoulli's theorem.

The process for drawing the optical fibre will now be described with reference to Figs. 5 to 9. One end of the primary optical fibre preform 46 prepared by internal deposition is firstly connected with a quartz tube of low purity, and the connected part is melted at 1400°C to form a swollen bulbous part shaped like a globe. Then, the quartz tube of low purity is removed from the primary optical fibre preform which is left with the bulbous end.

The primary optical fibre preform is arranged in the overcladding tube 44 with the swollen end taken by the lower end of the overcladding tube as shown in Fig. 8 and the other end fixedly mounted in the centre of the adjoiner as shown in Fig. 6A. The overcladding tube containing the primary optical fibre preform is rotated at 15 RPM while the swollen end, by the lower end of the overcladding tube, is heated at 1400°C for 3 to 4 minutes and the space between the primary optical fibre preform and overcladding tube is evacuated by passing nitrogen gas through the annular groove 56. Then, the bulbous end of the primary optical fibre preform and the adjacent end of the overcladding tube are stuck together by melting to give a secondary sealed preform consisting of the overcladding tube and primary optical fibre preform.

The secondary preform thus obtained is supplied to the furnace 28 under the control of the preform position control mechanism 35. When the furnace 28 is heated to a temperature of 2350°C and 15 minutes have elapsed, the space between the primary optical fibre preform and

overcladding tube is again evacuated by passing nitrogen gas through the annular groove 56. After 25 minutes, the bottom of the furnace is opened to let the molten part of the secondary preform fall. The molten part is pulled, keeping the diameter not exceeding 125µm, coated through the first and second coaters 30 and 32 and connected to the capstan 34, the speed of draw of which is automatically adjusted within a range of 300m to 700m per minute.

Thus, the present invention provides an apparatus for overcladding a primary optical fibre preform while drawing a final optical fibre which considerably reduces the production time and thus the cost.

CLAIMS:

1. A method of fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube comprising:

passing the primary optical fibre preform and the overcladding quartz tube substantially concentrically into a furnace to fuse the primary optical fibre preform and the overcladding tube into a secondary optical fibre preform; and

drawing an optical fibre from the secondary optical fibre preform within the furnace.

2. A method according to claim 1 comprising holding the primary optical fibre preform substantially centrally in the overcladding quartz tube in an adjoiner.

3. A method according to claim 2 in which the adjoiner includes means for evacuating the annular space between the primary optical fibre preform and the overcladding quartz tube.

4. A method according to claim 3 in which the means for evacuating the annular space comprises a suction tube and means for passing a flow of gas across the free end of the suction tube.

5. A method according to any one of claims 2-4 comprising:

inserting one end of the primary optical fibre preform to a quartz tube of comparatively low purity;

heating that end of the primary optical fibre preform to form a bulbous end;

removing the primary optical fibre preform and its bulbous end from the quartz tube of comparatively low purity;

locating one end of the overcladding quartz tube in the adjoiner and locating the primary optical fibre preform in the adjoiner such that its bulbous end is located at the

other end of the overcladding quartz tube.

6. A method of fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube substantially as described herein with reference to and/or as illustrated in FIGs. 5 et seq. of the accompanying drawings.

7. Apparatus for fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube comprising:

a furnace;

means for passing the primary optical fibre preform and the overcladding quartz tube substantially concentrically into the furnace to fuse the primary optical fibre preform and the overcladding tube into a secondary optical fibre preform; and

means for drawing an optical fibre from the secondary optical fibre preform within the furnace.

8. Apparatus according to claim 7 comprising an adjoiner for holding the primary optical fibre preform substantially centrally in the overcladding quartz tube is they are passed into the furnace.

9. Apparatus according to claim 8 in which the adjoiner includes means for evacuating the annular space between the primary optical fibre preform and the overcladding quartz tube.

10. Apparatus according to claim 9 in which the means for evacuating the annular space comprises a suction tube and means for passing a flow of gas across the free end of the suction tube.

11. Apparatus according to claim 10 in which the adjoiner is provided with an annular groove connected to a nitrogen gas inlet and outlet tube formed perpendicular to the length of the adjoiner, the suction tube being positioned

to extend to the space between the overcladding quartz tube and the primary optical fibre preform.

12. Apparatus according to any one of claims 8-11 in which a further quartz tube is further provided to connect the adjoiner with the overcladding quartz tube.

13. Apparatus according to any one of claims 7-12 in which the furnace has a hot zone at least 15cm in length.

14. Apparatus for fabricating an optical fibre from a primary optical fibre preform and an overcladding quartz tube substantially as described herein with reference to and/or as illustrated in FIGs. 5 et seq. of the accompanying drawings.

The Patent Office

Application No: GB 9711956.4
Claims searched: 1-14

Examiner: C A Clarke
Date of search: 4 September 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): C1M (MBA,MBB,MBL)

Int Cl (Ed.6): C03B 37/012

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2148874 A	STC see fig	1 and 7 at least
X	GB 2148273 A	STC see fig 3	1 and 7 at least
X	GB 2016445 A	NIPPON TELEGRAPH see fig 8	1 and 7 at least
X	GB 1427826	SUMITOMO see fig 4	1 and 7 at least
X	US 4820322	AT&T see figs 9 and 10	1 and 7 at least

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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